

PATENT APPLICATION

METHODS OF GENETIC ANALYSIS *USING NUCLEIC ACID ARRAYS*

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A METHODS OF GENETIC ANALYSIS USING NUCLEIC ACID ANALYSIS

CROSS REFERENCE TO RELATED APPLICATIONS

5 The present application is a non-provisional application claiming priority from
Provisional U.S. Patent Application Serial No. 60/100,678 filed September 17, 1998.

BACKGROUND OF THE INVENTION

10 The present invention provides a unique pool of nucleic acid sequences useful for
analyzing molecular interactions of biological interest. The invention therefore relates to
diverse fields impacted by the nature of molecular interaction, including chemistry, biology,
medicine, and medical diagnostics.

FIELD OF THE INVENTION

15 Many biological functions are carried out by regulating the expression levels of various
genes, either through changes in levels of transcription (*e.g.* through control of initiation,
provision of RNA precursors, RNA processing, *etc.*) of particular genes, through changes in the
copy number of the genetic DNA, or through changes in protein synthesis. For example,
control of the cell cycle and cell differentiation, as well as diseases, are characterized by the
variations in the transcription levels of a group of genes.

20 Gene expression is not only responsible for physiological functions, but also associated
with pathogenesis. For example, the lack of sufficient functional tumor suppressor genes and/or
the over expression of oncogene/protooncogenes leads to tumorigenesis. (See, *e.g.*, Marshall,
Cell, 64: 313-326 (1991) and Weinberg, *Science*, 254: 1138-1146 (1991.)) Thus, changes in the

expression levels of particular genes (*e.g.* oncogenes or tumor suppressors), serve as signposts for the presence and progression of various diseases.

As a consequence, novel techniques and apparatus are needed to study gene expression in specific biological systems.

5 All documents, *i.e.*, publications and patent applications, cited in this disclosure, including the foregoing, are incorporated by reference herein in their entireties for all purposes to the same extent as if each of the individual documents were specifically and individually indicated to be so incorporated by reference herein in its entirety.

SUMMARY OF THE INVENTION

10 The invention provides nucleic acid sequences which are complementary to particular genes and makes them available for a variety of analyses, including, for example, gene expression analysis. For example, in one embodiment the invention comprises an array comprising of any 10 or more, 100 or more, 1000, or more, 10,000 or more or 100,000 or more nucleic acid probes containing 9 or more consecutive nucleotides from the sequences listed in
15 SEQ ID NOS: 1 -127811, or the perfect match, perfect mismatch, antisense match or antisense mismatch thereof. In a further embodiment, the invention comprises the use of any of the above arrays or fragments disclosed in TABLE 1 to: monitor gene expression levels by hybridization of the array to a DNA library; monitor gene expression levels by hybridization to an mRNA-protein fusion compound; identify polymorphisms; identify biallelic markers; produce genetic
20 maps; analyze genetic variation; comparatively analyze gene expression between different species; analyze gene knockouts; or, to hybridize tag-labeled compounds. In a further embodiment the invention comprises a method of analysis comprising of hybridizing one or

more pools of nucleic acids to two or more of the fragments disclosed in TABLE 1 and detecting said hybridization. In a further embodiment the invention comprises the use of any one or more of the fragments disclosed in TABLE 1 as a primer for PCR. In a further embodiment the invention comprises the use of any one or more of the fragments disclosed in
5 TABLE 1 as a ligand.

DETAILED DESCRIPTION OF THE INVENTION

I. Definitions

10 Massive Parallel Screening: The phrase "massively parallel screening" refers to the simultaneous screening of at least about 100, preferably about 1000, more preferably about 10,000 and more preferably about 100,000 different nucleic acid hybridizations.

Nucleic Acid: The terms "nucleic acid" or "nucleic acid molecule" refer to a deoxyribonucleotide or ribonucleotide polymer in either single-or double-stranded form, and
15 unless otherwise limited, would encompass analogs of natural nucleotides that can function in a similar manner as naturally occurring nucleotides. Nucleic acids may be derived from a variety or sources including, but not limited to, naturally occurring nucleic acids, clones, synthesis in solution or solid phase synthesis.

Probe: As used herein a "probe" is defined as a nucleic acid capable of binding to a target
20 nucleic acid of complementary sequence through one or more types of chemical bonds, usually through complementary base pairing, usually through hydrogen bond formation. As used herein, a probe may include natural (*i.e.* A, G, U, C, or T) or modified bases (7-deazaguanosine,

inosine, *etc.*). In addition, the bases in probes may be joined by a linkage other than a phosphodiester bond, so long as it does not interfere with hybridization. Thus, probes may be peptide nucleic acids in which the constituent bases are joined by peptide bonds rather than phosphodiester linkages.

5 Target nucleic acid: The term "target nucleic acid" or "target sequence" refers to a nucleic acid or nucleic acid sequence which is to be analyzed. A target can be a nucleic acid to which a probe will hybridize. The probe may or may not be specifically designed to hybridize to the target. It is either the presence or absence of the target nucleic acid that is to be detected, or the amount of the target nucleic acid that is to be quantified. The term target nucleic acid
10 may refer to the specific subsequence of a larger nucleic acid to which the probe is directed or to the overall sequence (*e.g.*, gene or mRNA) whose expression level it is desired to detect. The difference in usage will be apparent from context.

 mRNA or transcript: The term "mRNA" refers to transcripts of a gene. Transcripts are RNA including, for example, mature messenger RNA ready for translation, products of various
15 stages of transcript processing. Transcript processing may include splicing, editing and degradation.

 Subsequence: "Subsequence" refers to a sequence of nucleic acids that comprise a part of a longer sequence of nucleic acids.

 Perfect match: The term "match," "perfect match," "perfect match probe" or "perfect
20 match control" refers to a nucleic acid that has a sequence that is perfectly complementary to a particular target sequence. The nucleic acid is typically perfectly complementary to a portion (subsequence) of the target sequence. A perfect match (PM) probe can be a "test probe", a

"normalization control" probe, an expression level control probe and the like. A perfect match control or perfect match is, however, distinguished from a "mismatch" or "mismatch probe."

Mismatch: The term "mismatch," "mismatch control" or "mismatch probe" refers to a nucleic acid whose sequence is deliberately selected not to be perfectly complementary to a particular target sequence. As a non-limiting example, for each mismatch (MM) control in a high-density probe array there typically exists a corresponding perfect match (PM) probe that is perfectly complementary to the same particular target sequence. The mismatch may comprise one or more bases. While the mismatch(es) may be located anywhere in the mismatch probe, terminal mismatches are less desirable because a terminal mismatch is less likely to prevent hybridization of the target sequence. In a particularly preferred embodiment, the mismatch is located at or near the center of the probe such that the mismatch is most likely to destabilize the duplex with the target sequence under the test hybridization conditions. A homo-mismatch substitutes an adenine (A) for a thymine (T) and vice versa and a guanine (G) for a cytosine (C) and vice versa. For example, if the target sequence was: AGGTCCA, a probe designed with a single homo-mismatch at the central, or fourth position, would result in the following sequence: TCCTGGT.

Array: An "array" is a solid support with at least a first surface having a plurality of different nucleic acid sequences attached to the first surface.

Gene Knockout: the term "gene knockout," as defined in Lodish et al *Molecular Cell Biology 3rd Edition*, Scientific American Books pub., which is hereby incorporated in its entirety for all purposes is, is a technique for selectively inactivating a gene by replacing it with a mutant allele in an otherwise normal organism.

DNA Library - as used herein the term "genomic library" or "genomic DNA library" refers to a collection of cloned DNA molecules consisting of fragments of the entire genome (genomic library) or of DNA copies of all the mRNA produced by a cell type (cDNA library) inserted into a suitable cloning vector.

5 Polymorphism - "polymorphism" refers to the occurrence of two or more genetically determined alternative sequences or alleles in a population. A polymorphic marker or site is the locus at which divergence occurs. Preferred markers have at least two alleles, each occurring at a frequency of greater than 1%, and more preferably greater than 10% or 20% of the selected population. A polymorphic locus may be as small as one base pair. Polymorphic markers
10 include restriction fragment length polymorphisms, variable number or tandem repeats (VNTR's), hypervariable regions, minisatellites, dinucleotide repeats, trinucleotide repeats, tetranucleotide repeats, simple sequence repeats, and insertion elements such as ALU. The first identified allelic form is arbitrarily designated as the reference form and other allelic forms are designated as alternative or variant alleles. The allelic form occurring most frequently in a
15 selected population is sometimes referred to as the wildtype form. Diploid organisms may be homozygous or heterozygous for allelic forms. A diallelic or biallelic polymorphism has two forms. A triallelic polymorphism has three forms.

Genetic map - a "genetic map" is a map which presents the order of specific sequences on a chromosome.

20 Genetic variation - "genetic variation" refers to variation in the sequence of the same region between two or more organisms.

Hybridization - the association of two complementary nucleic acid strands or their derivatives (such as PNA) to form double stranded molecules. Hybrids can contain two DNA strands, two RNA strands, or one DNA and one RNA strand.

mRNA-protein fusion - a compound whereby an mRNA is directly attached to the peptide or protein it incodes by a stable covalent linkage.

Ligand - any molecule, other than an enzyme substrate, that binds tightly and specifically to a macromolecule, for example, a protein, forming a macromolecule-ligand complex.

II. General

TABLE 1, encompassed in Appendix I, presents target sequences included in the invention. Each target sequence from columns 2,5 and 8 corresponds to and represents at least four additional nucleic acid sequences included in the invention. For example, if the first nucleic acid sequence listed in TABLE 1 is: **cgccggaagcggtccaatcaacat** the additional sequences included in the invention which are represented by this nucleic acid sequence are, for example, :

gcggcctttcgcacggccagttgta = (perfect) sense match

gcggcctttcgctcgccagttgta = sense mismatch

tacaactggccgagcgaaaggccgc = (perfect) antisense match

tacaactggccgtgcgaaaggccgc = antisense mismatch

Accordingly, for each nucleic acid sequence listed in TABLE 1, this disclosure includes the corresponding sense match, sense mismatch, antisense match and antisense mismatch. The

position of the mismatch is not limited to the above example, it may be located anywhere in the nucleic acid sequence and may comprise one or more bases.

Consequently, the present invention includes: a) the target sequences listed in TABLE 1, columns 2, 5 and 8 or the sense-match, sense mismatch, antisense match or antisense mismatch thereof; b) clones which comprise the target nucleic acid sequences listed in TABLE 1, columns 2, 5 and 8 or the sense-match, sense mismatch, antisense match or antisense mismatch thereof; c) longer nucleotide sequences which include the nucleic acid sequences listed in TABLE 1, columns 2, 5, and 8 or the sense-match, sense mismatch, antisense match or antisense mismatch thereof and d) subsequences greater than 9 nucleotides in length of the target nucleic acid sequences listed in TABLE 1, columns 2, 5, and 8 or the sense match, sense mismatch, antisense match or antisense mismatch.

Target sequences were chosen from clusters of known murine genes available on the Unigene database as of August 15, 1996. Target sequences were selected using the computer based methods described in US patent application No. 08/772,376 incorporated herein by reference for all purposes.

For each target sequence listed in TABLE 1 is a corresponding genbank database accession number. These accession numbers allow for the identification of sequences located in the genbank sequence database through the use of computer programs such as BLAST. Access to BLAST is available to the public through the internet at, for example, <http://www.ncbi.nlm.nih.gov>. One of skill in the art will be familiar with the use of the BLAST program to obtain information about particular sequences in order to, for example, determine the species from which the sequence is derived, determine the gene from which the sequence is

derived, to determine other genes and species which contain similar sequences and to determine the degree of similarity between one sequence and another. All information relating to the target sequences available through the genbank database is hereby incorporated by reference for all purposes.

5 The present invention provides a pool of unique nucleotide sequences complementary to murine genes and ESTs in particular embodiments which alone, or in combinations of 2 or more, 10 or more, 100 or more, 1,000 or more, 10,000 or more, or 100,000 or more, can be used for a variety of applications.

10 In one embodiment, the present invention provides for a pool of unique nucleotide sequences which are complementary to approximately 6500 murine genes formed into a high density array of probes suitable for array based massive parallel gene expression. Array based methods for monitoring gene expression are disclosed and discussed in detail in U.S. Patent No. Applications, 08/670,118, and 08/772,376 and PCT Application WO 92/10588 (published on June 25, 1992), all of which are incorporated herein by reference for all purposes. Generally
15 those methods of monitoring gene expression involve (1) providing a pool of target nucleic acids comprising RNA transcript(s) of one or more target gene(s), or nucleic acids derived from the RNA transcript(s); (2) hybridizing the nucleic acid sample to a high density array of probes and (3) detecting the hybridized nucleic acids and calculating a relative expression
(transcription, RNA processing or degradation) level.

20 The development of Very Large Scale Immobilized Polymer Synthesis or VLSIPS™ technology has provided methods for making very large arrays of nucleic acid probes in very small arrays. See U.S. Patent No. 5,143,854 and PCT patent publication Nos. WO 90/15070

and 92/10092, and Fodor *et al.*, *Science*, 251, 767-77 (1991), each of which is incorporated herein by reference. U.S. Patent application Serial No. 08/670,118, describes methods for making arrays of nucleic acid probes that can be used to detect the presence of a nucleic acid containing a specific nucleotide sequence. Methods of forming high density arrays of nucleic acids, peptides and other polymer sequences with a minimal number of synthetic steps are known. The nucleic acid array can be synthesized on a solid substrate by a variety of methods, including, but not limited to, light-directed chemical coupling, and mechanically directed coupling.

In a preferred detection method, the array of immobilized nucleic acids, or probes, is contacted with a sample containing target nucleic acids, to which a fluorescent label is attached. Target nucleic acids hybridize to the probes on the array and any non-hybridized nucleic acids are removed. The array containing the hybridized target nucleic acids are exposed to light which excites the fluorescent label. The resulting fluorescent intensity, or brightness, is detected. Relative brightness is used to determine which probe is the best candidate for the perfect match to the hybridized target nucleic acid because fluorescent intensity (brightness) corresponds to binding affinity. Once the position of the perfect match probe is known, the sequence of the hybridized target nucleic is known because the sequence and position of the probe is known.

In the array of the present invention the probes are presented in pairs, one probe in each pair being a perfect match to the target sequence and the other probe being identical to the perfect match probe except that the central base is a homo-mismatch. Mismatch probes provide a control for non-specific binding or cross-hybridization to a nucleic acid in the sample other

than the target to which the probe is directed. Thus, mismatch probes indicate whether a hybridization is or is not specific. For example, if the target is present, the perfect match probes should be consistently brighter than the mismatch probes because fluorescence intensity, or brightness, corresponds to binding affinity. (See, for example US Patent No. 5,324,633, which is incorporated herein for all purposes.) In addition, if all central mismatches are present, the mismatch probes can be used to detect a mutation. Finally the difference in intensity between the perfect match and the mismatch probe ($I(\text{PM}) - I(\text{MM})$) provides a good measure of the concentration of the hybridized material. See pending PCT application No. 98/11223, which is incorporated herein by reference for all purposes. The probe pairs are presented in both sense and antisense orientation, thereby eliciting a total of four probes per target sequence: sense match, sense mismatch, antisense match and antisense mismatch.

In another embodiment, the current invention provides a pool of sequences which may be used as probes for their complementary genes listed in the genbank database. Methods for making probes are well known. See for example Sambrook, Fritsche and Maniatis. "Molecular Cloning A laboratory Manual" 2nd Ed. Cold Spring Harbor Press (1989) ("Maniatis et al.") which is hereby incorporated in its entirety by reference for all purposes. Maniatis et al. describes a number of uses for nucleic acid probes of defined sequence. Some of the uses described by Maniatis et al. include: to screen cDNA or genomic DNA libraries, or subclones derived from them, for additional clones containing segments of DNA that have been isolated and previously sequenced; in Southern, northern, or dot-blot hybridization to identify or detect the sequences of specific genes; in Southern, or dot-blot hybridization of genomic DNA to detect specific mutations in genes of known sequence; to detect specific mutations generated by

site-directed mutagenesis of cloned genes; and to map the 5' termini of mRNA molecules by primer extensions. Maniatis et al. describes other uses for probes throughout. See also Alberts et al. *Molecular Biology of the Cell 3rd edition*, Garland Publishing Inc. (1994) p. 307 and Lodish et al. *Molecular Cell Biology, 3rd edition*, Scientific American Books (1995) p. 285-286, each of which is hereby incorporated by reference in its entirety for all purposes, for a brief discussion of the use of nucleic acid probes in *in situ hybridization*. Other uses for probes derived from the sequences disclosed in this invention will be readily apparent to those of skill in the art. See, for example, Lodish et al. *Molecular Cell Biology, 3rd edition*, Scientific American Books (1995) p.229-233, incorporated above, for a description of the construction of genomic libraries.

In another embodiment, the current invention may be combined with known methods to monitor expression levels of genes in a wide variety of contexts. For example, where the effects of a drug on gene expression are to be determined, the drug will be administered to an organism, a tissue sample, or a cell and the gene expression levels will be analyzed. For example, nucleic acids are isolated from the treated tissue sample, cell, or a biological sample from the organism and from an untreated organism tissue sample or cell, hybridized to a high density probe array containing probes directed to the gene of interest and the expression levels of that gene are determined. The types of drugs that may be used in these types of experiments include, but are not limited to, antibiotics, antivirals, narcotics, anti-cancer drugs, tumor suppressing drugs, and any chemical composition which may affect the expression of genes *in vivo* or *in vitro*. The current invention is particularly suited to be used in the types of analyses described by, for example, pending US Applications No. 08/772,376 and PCT Application No. 98/11223, each of

which is incorporated by reference in its entirety for all purposes. As described in Wodicka et al., *Nature Biotechnology* 15 (1997), (hereby incorporated by reference in its entirety for all purposes), because mRNA hybridization correlates to gene expression level, hybridization patterns can be compared to determine differential gene expression. As non-limiting examples:

5 hybridization patterns from samples treated with certain types of drugs may be compared to hybridization patterns from samples which have not been treated or which have been treated with a different drug; hybridization patterns for samples infected with a specific virus may be compared against hybridization patterns from non-infected samples; hybridization patterns for samples with cancer may be compared against hybridization patterns for samples without
10 cancer; hybridization patterns of samples from cancerous cells which have been treated with a tumor suppressing drug may be compared against untreated cancerous cells, etc. Zhang et al., *Science* 276 1268-1272, (hereby incorporated by reference in its entirety for all purposes), provides an example of how gene expression data can provide a great deal of insight into cancer research. One skilled in the art will appreciate that a wide range of applications will be
15 available using 2 or more, 10 or more, 100 or more, 1000 or more, 10,000 or more or 100,000 or more of the Table 1 sequences as probes for gene expression analysis. The combination of the DNA array technology and the mouse specific probes in this disclosure is a powerful tool for studying gene expression.

In another embodiment, the invention may be used in conjunction with the techniques
20 which link specific proteins to the mRNA which encodes the protein. (See for example Roberts and Szostak *Proc. Natl. Acad. Sci.* 94 12297-12302 (1997) which is incorporated herein in its entirety for all purposes.) Hybridization of these mRNA-protein fusion compounds to arrays

comprised of 2 or more, 10 or more, 100 or more, 1000 or more, 10,000 or more, or 100,000 or more the sequences disclosed in the present invention provides a powerful tool for monitoring expression levels.

In one embodiment, the current invention provides a pool of unique nucleic acid sequences which can be used for parallel analysis of gene expression under selective conditions. Without wishing to be limited, genetic selection under selective conditions could include: variation in the temperature of the organism's environment; variation in pH levels in the organism's environment; variation in an organism's food (type, texture, amount etc.); variation in an organism's surroundings; etc. Arrays, such as those in the present invention, can be used to determine whether gene expression is altered when an organism is exposed to selective conditions.

Methods for using nucleic acid arrays to analyze genetic selections under selective conditions are known. (See for example, R. Cho et al., Proc. Natl. Acad. Sci. 95 3752-3757 (1998) incorporated herein in its entirety for all purposes.) Cho et al. describes the use of a high-density array containing oligonucleotides complementary to every gene in the yeast *Saccharomyces cerevisiae* to perform two-hybrid protein-protein interaction screens for *S. cerevisiae* genes implicated in mRNA splicing and microtubule assembly. Cho et al. was able to characterize the results of a screen in a single experiment by hybridization of labeled DNA derived from positive clones. Briefly, as described by Cho et al., two proteins are expressed in yeast as fusions to either the DNA-binding domain or the activation domain of a transcription factor. Physical interaction of the two proteins reconstitutes transcriptional activity, turning on a gene essential for survival under selective conditions. In screening for novel protein-protein

interactions, yeast cells are first transformed with a plasmid encoding a specific DNA-binding fusion protein. A plasmid library of activation domain fusions derived from genomic DNA is then introduced into these cells. Transcriptional activation fusions found in cells that survive selective conditions are considered to encode peptide domains that may interact with the DNA-binding domain fusion protein. Clones are then isolated from the two-hybrid screen and mixed into a single pool. Plasmid DNA is purified from the pooled clones and the gene inserts are amplified using PCR. The DNA products are then hybridized to yeast whole genome arrays for characterization. The methods employed by Cho et al. are applicable to the analysis of a range of genetic selections. High density arrays created using two or more, 10 or more, 100 or more, 1000 or more, 10,000 or more, or 100,000 or more of the sequences disclosed in the current invention can be used to analyze genetic selections in the mouse system using the methods described in Cho et al.

In another embodiment, the current invention provides a pool of unique nucleic acid sequences which can be used to identify biallelic markers, providing a novel and efficient approach to the study of genetic variation. For example, methods for using high density arrays comprised of probes which are complementary to the genomic DNA of a particular species to interrogate polymorphisms are well known. (See for example, US Patent Application Nos. 08/965,620 and 08/853,370 which are hereby incorporated herein for all purposes.) Pools of 2 or more, 10 or more, 100 or more, 1000 or more, 10,000 or more, or 100,000 or more of the sequences disclosed in this invention combined with the methods described in the above patent applications provides a tool for studying genetic variation in the mouse system.

In another embodiment of the invention, genetic variation can be used to produce genetic maps of various strains of mouse. Winzler et al., "Direct Allelic Variation Scanning of the Yeast Genome" Science (in press) (1998), which is hereby incorporated for all purposes describe methods for conducting this type of screening with arrays containing probes
5 complementary to the yeast genome. Briefly, genomic DNA from strains which are phenotypically different are isolated, fragmented, and labelled. Each strain is then hybridized to identical arrays comprised of the nucleic acid sequences complementary to the system being studied. Comparison of hybridization patterns between the various strains then serve as genetic markers. As described by Winzler et al, these markers can then be used for linkage analysis.
10 High density arrays created from 2 or more, 10 or more, 100 or more, 1000 or more, 10,000 or more, or 100,000 or more of the sequences disclosed in this invention can be used to study genetic variation using the methods described by Winzler et al.

In another embodiment, the present invention may be used for cross-species comparisons. One skilled in the art will appreciate that it is often useful to determine whether a
15 gene present in one species, for example the mouse, is present in a conserved format in another species, including, without limitation, mouse, human, chicken, zebrafish, *drosophila*, or yeast. See, for example, Andersson et al., Mamm Genome 7(10):717-734 (1996,) which is hereby incorporated by reference for all purposes, which describes the utility of cross-species comparisons. The use of 2 or more, 10 or more, 100 or more, 1000 or more, 10,000 or more or
20 100,000 or more of the sequences disclosed in this invention in an array can be used to determine whether any of the sequence from one or more of the murine genes represented by the sequences disclosed in this invention is conserved in another species by, for example,

hybridizing genomic nucleic acid samples from another species to an array comprised of the sequences disclosed in this invention. Areas of hybridization will yield genomic regions where the nucleotide sequence is highly conserved between the interrogation species and the mouse.

In another embodiment, the present invention may be used to characterize the genotype of knockouts. Methods for using gene knockouts to identify a gene are well known. See for example, Lodish et al. *Molecular Cell Biology*, 3rd Edition, Scientific American Books pub pp. 292-296 and US Patent No. 5,679,523 which are hereby incorporated by reference for all purposes. By isolating genomic nucleic acid samples from knockout species with a known phenotype and hybridizing the samples to an array comprised of 2 or more, 10 or more, 100 or more, 1000 or more, 10,000 or more, or 100,000 or more of the sequences disclosed in this invention, candidates genes which contribute to the phenotype will be identified and made accessible for further characterization.

In another embodiment, the present invention may be used to identify new gene family members. Methods of screening libraries with probes are well known. (See, for example, Maniatis et al, incorporated by reference above.) Because the present invention is comprised of nucleic acid sequences from specific known genes, 2 or more, 10 or more, 100 or more, 1000 or more, 10,000 or more, or 100,000 or more of sequences disclosed in this invention may be used as probes to screen genomic libraries to look for additional family members of those genes from which the target sequences are derived.

In another embodiment, the present invention may be used to provide nucleic acid sequences to be used as tag sequences. Tag sequences are a type of genetic "bar code" which can be used to label compounds of interest. The analysis of deletion mutants using tag

sequences is described in, for example, Shoemaker et al., Nature Genetics 14 450-456 (1996), which is hereby incorporated by reference in its entirety for all purposes. Shoemaker et al. describes the use of PCR to generate large numbers of deletion strains. Each deletion strain is labelled with a unique 20-base tag sequence that can be hybridized to a high-density oligonucleotide array. The tags serve as unique identifiers (molecular bar codes) that allow analysis of large numbers of deletion strains simultaneously through selective growth conditions. The use of tag sequences need not be limited to this example however. The utility of using unique known short oligonucleotide sequences capable of hybridizing to a nucleic acid array to label various compounds will be apparent to one skilled in the art. One or more, 10 or more, 100 or more, 1000 or more, 10,000 or more, or 100,000 or more of the Table 1 sequences are excellent candidates to be used as tag sequences.

In another embodiment of the invention, the sequences of this invention may be used to generate primers directed to their corresponding genes as disclosed in the Genbank or any other public database. These primers may be used in such basic techniques as sequencing or PCR, see for example Maniatis et al., incorporated by reference above.

In another embodiment, the invention provides a pool of nucleic acid sequences to be used as ligands for specific genes. The sequences disclosed in this invention may be used as ligands to their corresponding genes as disclosed in the Genbank or any other public database. Compounds which specifically bind known genes are of interest for a variety of uses. One particular clinical use is to act as an antisense protein which specifically binds and disables a gene which has been, for example, linked to a disease. Methods and uses for ligands to specific

genes are known. See for example, US Patent No. 5,723,594 which is hereby incorporated by reference in its entirety for all purposes.

In a preferred embodiment, the hybridized nucleic acids are detected by detecting one or more labels attached to the sample nucleic acids. The labels may be incorporated by any of a number of means well known to those of skill in the art. In one embodiment, the label is simultaneously incorporated during the amplification step in the preparation of the sample nucleic acids. Thus, for example, polymerase chain reaction (PCR) with labeled primers or labeled nucleotides will provide a labeled amplification product. In another embodiment, transcription amplification, as described above, using a labeled nucleotide (*e.g.* fluorescein-labeled UTP and/or CTP) incorporates a label into the transcribed nucleic acids.

Alternatively, a label may be added directly to the original nucleic acid sample (*e.g.*, mRNA, polyA mRNA, cDNA, *etc.*) or to the amplification product after the amplification is completed. Means of attaching labels to nucleic acids are well known to those of skill in the art and include, for example nick translation or end-labeling (*e.g.* with a labeled RNA) by kinasing of the nucleic acid and subsequent attachment (ligation) of a nucleic acid linker joining the sample nucleic acid to a label (*e.g.*, a fluorophore).

Detectable labels suitable for use in the present invention include any composition detectable by spectroscopic, photochemical, biochemical, immunochemical, electrical, optical or chemical means. Useful labels in the present invention include biotin for staining with labeled streptavidin conjugate, magnetic beads (*e.g.*, Dynabeads™), fluorescent dyes (*e.g.*, fluorescein, texas red, rhodamine, green fluorescent protein, and the like), radiolabels (*e.g.*, ^3H , ^{125}I , ^{35}S , ^{14}C , or ^{32}P), phosphorescent labels, enzymes (*e.g.*, horse radish peroxidase, alkaline phosphatase and

others commonly used in an ELISA), and colorimetric labels such as colloidal gold or colored glass or plastic (e.g., polystyrene, polypropylene, latex, etc.) beads. Patents teaching the use of such labels include U.S. Patent Nos. 3,817,837; 3,850,752; 3,939,350; 3,996,345; 4,277,437; 4,275,149; and 4,366,241, each of which is hereby incorporated by reference in its entirety for all purposes.

Means of detecting such labels are well known to those of skill in the art. Thus, for example, radiolabels may be detected using photographic film or scintillation counters, fluorescent markers may be detected using a photodetector to detect emitted light. Enzymatic labels are typically detected by providing the enzyme with a substrate and detecting the reaction product produced by the action of the enzyme on the substrate, and colorimetric labels are detected by simply visualizing the colored label.

The label may be added to the target nucleic acid(s) prior to, or after the hybridization. So called "direct labels" are detectable labels that are directly attached to or incorporated into the target nucleic acid prior to hybridization. In contrast, so called "indirect labels" are joined to the hybrid duplex after hybridization. Often, the indirect label is attached to a binding moiety that has been attached to the target nucleic acid prior to the hybridization. Thus, for example, the target nucleic acid may be biotinylated before the hybridization. After hybridization, an avidin-conjugated fluorophore will bind the biotin bearing hybrid duplexes providing a label that is easily detected. For a detailed review of methods of labeling nucleic acids and detecting labeled hybridized nucleic acids see *Laboratory Techniques in Biochemistry and Molecular Biology, Vol. 24: Hybridization With Nucleic Acid Probes*, P. Tijssen, ed. Elsevier, N.Y., (1993) which is hereby incorporated by reference in its entirety for all purposes.

Fluorescent labels are preferred and easily added during an *in vitro* transcription reaction. In a preferred embodiment, fluorescein labeled UTP and CTP are incorporated into the RNA produced in an *in vitro* transcription reaction as described above.

EXAMPLE

The following example serves to illustrate the type of experiment that could be conducted using the invention.

Expression Monitoring by Hybridization to High Density Oligonucleotide Arrays

Arrays containing the desired number of probes can be synthesized using the method described in US Patent No. 5,143,854, incorporated by reference above. Extracted poly (A)⁺RNA can then be converted to cDNA using the methods described below. The cDNA is then transcribed in the presence of labeled ribonucleotide triphosphates. The label may be biotin or a dye such as fluorescein. RNA is then fragmented with heat in the presence of magnesium ions. Hybridizations are carried out in a flow cell that contains the two-dimensional DNA probe arrays. Following a brief washing step to remove unhybridized RNA, the arrays are scanned using a scanning confocal microscope.

1. A method of RNA preparation:

Labeled RNA is prepared from clones containing a T7 RNA polymerase promoter site by incorporating labeled ribonucleotides in an IVT reaction. Either biotin-labeled or fluorescein-labeled UTP and CTP (1:3 labeled to unlabeled) plus unlabeled ATP and GTP is used for the reaction with 2500 U of T7 RNA polymerase. Following the reaction unincorporated nucleotide triphosphates are removed using size-selective membrane such as Microcon - 100, (Amicon, Beverly, MA). The total molar concentration of RNA is based on a measurement of the absorbance at 260 nm. Following quantitation of RNA amounts, RNA is fragmented randomly to an average length of approximately 50 bases by heating at 94° in 40 mM Tris-acetate pH 8.1, 100 mM potassium acetate, 30 mM magnesium acetate, for 30 to 40 min. Fragmentation reduces possible interference from RNA secondary structure, and minimizes the effects of multiple interactions with closely spaced probe molecules. For material

made directly from cellular RNA, cytoplasmic RNA is extracted from cells by the method of Favaloro et al. *Methods Enzymol.* 65:718-749 (1980) hereby incorporated by reference for all purposes, and poly (A)⁺ RNA is isolated with an oligo dT selection step using, for example, Poly Atract, (Promega, Madison, WI). RNA can be amplified using a modification of the procedure described by Eberwine et al. *Proc. Natl. Acad. Sci. USA* 89:3010-3014 (1992) hereby incorporated by reference for all purposes. Microgram amounts of poly (A)⁺ RNA are converted into double stranded cDNA using a cDNA synthesis kit (kits may be obtained from Life Technologies, Gaithersburg, MD) with an oligo dT primer incorporating a T7 RNA polymerase promoter site. After second-strand synthesis, the reaction mixture is extracted with phenol/chloroform, and the double-stranded DNA isolated using a membrane filtration step using, for example, Microcon -100, (Amicon). Labeled cRNA can be made directly from the cDNA pool with an IVT step as described above. The total molar concentration of labeled cRNA is determined from the absorbance at 260nm and assuming an average RNA size of 1000 ribonucleotides. The commonly used convention is that 1 OD is equivalent to 40 ug of RNA, and that 1 ug of cellular mRNA consists of 3 pmol of RNA molecules. Cellular mRNA may also be labeled directly without any intermediate cDNA synthesis steps. In this case, Poly (A)⁺ RNA is fragmented as described, and the 5' ends of the fragments are kinased and then incubated overnight with a biotinylated oligoribonucleotide (5'-biotin-AAAAAA-3') in the presence of T4 RNA ligase (available from Epicentre Technologies, Madison, WI). Alternatively, mRNA has been labeled directly by UV-induced cross-linking to a psoralen derivative linked to biotin (available from Schleicher & Schuell, Keene, NH).

2. Array hybridization and Scanning:

Array hybridization solutions can be made containing 0.9 M NaCl, 60mM EDTA, and 0.005% Triton X-100, adjusted to pH 7.6 (referred to as 6xSSPE-T). In addition, the solutions should contain 0.5 mg/ml unlabeled, degraded herring sperm DNA (available from Sigma, St. Louis, MO). Prior to hybridization, RNA samples are heated in the hybridization solution to 99°C for 10 min, placed on ice for 5 min, and allowed to equilibrate at room temperature before being placed in the hybridization flow cell. Following hybridization, the solutions are removed, the arrays washed with 6xSSPE-T at 22°C for 7 min, and then washed with 0.5xSSPE-T at 40°C for 15 min. When biotin labeled RNA is used the hybridized RNA should be stained with a

streptavidin-phycoerythrin in 6xSSPE-T at 40°C for 5 min. The arrays are read using a scanning confocal microscope made by Molecular Dynamics (commercially available through Affymetrix, Santa Clara, CA). The scanner uses an argon ion laser as the excitation source, with the emission detected by a photomultiplier tube through either a 530 nm bandpass filter (fluorescein) or a 560 nm longpass filter (phycoerythrin). Nucleic acids of either sense or antisense orientations may be used in hybridization experiments. Arrays for probes with either orientation (reverse complements of each other) are made using the same set of photolithographic masks by reversing the order of the photochemical steps and incorporating the complementary nucleotide.

3. Quantitative analysis of hybridization patterns and intensities.

Following a quantitative scan of an array, a grid is aligned to the image using the known dimensions of the array and the corner control regions as markers. The image is then reduced to a simple text file containing position and intensity information using software developed at Affymetrix (available with the confocal scanner). This information is merged with another text file that contains information relating physical position on the array to probe sequence and the identity of the RNA (and the specific part of the RNA) for which the oligonucleotide probe is designed. The quantitative analysis of the hybridization results involves a simple form of pattern recognition based on the assumption that, in the presence of a specific RNA, the perfect match (PM) probes will hybridize more strongly on average than their mismatch (MM) partners. The number of instances in which the PM hybridization is larger than the MM signal is computed along with the average of the logarithm of the PM/MM ratios for each probe set. These values are used to make a decision (using a predefined decision matrix) concerning the presence or absence of an RNA. To determine the quantitative RNA abundance, the average of the difference (PM-MM) for each probe family is calculated. The advantage of the difference method is that signals from random cross-hybridization contribute equally, on average, to the PM and MM probes, while specific hybridization contributes more to the PM probes. By averaging the pairwise differences, the real signals add constructively while the contributions from cross-hybridization tend to cancel. When assessing the differences between two different RNA samples, the hybridization signals from side-by-side experiments on identically synthesized arrays are compared directly. The magnitude of the changes in the average of the

difference (PM-MM) values is interpreted by comparison with the results of spiking experiments as well as the signals observed for the internal standard bacterial and phase RNAs spiked into each sample at a known amount. Data analysis programs, such as those described in US Patent No.08/828,952 perform these operations automatically.

5

CONCLUSION

The inventions herein provide a pool of unique nucleic acid sequences which are complementary to approximately 6500 specific known murine genes. These sequences can be used for a variety of types of analyses.

10 The above description is illustrative and not restrictive. Many variations of the invention will become apparent to those of skill in the art upon review of this disclosure. The scope of the invention should, therefore, be determined not with reference to the above description, but instead be determined with reference to the appended claims along with their full scope of equivalents.

15

TABLE 1

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TABLE 1

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TABLE 1

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207	ttcatgaggcgacaggttctcaaat	L38424	42811	catgaccacggcggaatgaaggtc	AA020046	85415	tgctgtgctgttagtcaagactat	W35962
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209	tgactgatcgctgccaatgcactc	L38424	42813	tgaccacggcggaatgaaggtctt	AA020046	85417	caagactatagaccaggttgaatat	W35962
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TABLE 1

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275	tcgatctcataacggacaaactga	X17013	42879	cagctcagttatccacaaattg	U14135	85483	gacctccagcgcagctggagaac	AA106166
276	attacaatcggaacacattcagctg	X17013	42880	aagagcctctgtgtaaccaaggct	U27295	85484	cctccagcgcagctggagaaactg	AA106166
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TABLE 1

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343	ccatcccgagctgaataatcggggtc	M24537	42947	cactgctgcatctactcaact	AA161905	85551	gcattaccctgttgcagtcgaagat	AA106601
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TABLE 1

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411	tgccgatgcccgtaaagcaagtgct	X04603	43015	ctgtacacactctggcagcacaaca	AA020222	85619	accagagaagtggtctctactgtgccc	D10024
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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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1291	gtcgtgcaccttagagcatttgaat	X03919	43895	atcctgtaccaggtgtgtgtgtg	AA020650	86499	ttgctgtccaaactctaaataat	X99946
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TABLE 1

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1322	acggactctgagtgccctgtgcatc	W44201	43926	ctcctgtgagcaggtgttggagcgg	U53584	86530	tttggtaaccgagatgtctcaag	U31966
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1324	atgtcaggtctgttaaagggttaag	M12289	43928	ctgctgtgtatgtctgtagcagtg	U53584	86532	ggtagcagctctgtccagaatcctt	U31966
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1327	gtaaacacatcttcagaggaagga	M12289	43931	ccaaactcctggaacagtggtctt	U53584	86535	cagaatcctgtccaggaaactcaat	U31966
1328	acacatcttcagaggaaggaggct	M12289	43932	tcttgggaacagtggttccctgt	U53584	86536	aatctgtccaggaaactcaatgag	U31966
1329	acatcttcagaggaaggaggctgc	M12289	43933	tctgtgtcccaggtgtgacttaga	U53584	86537	cctgtccaggaaactcaatgagag	U31966
1330	gctgccaagggtctgaaggaaagca	M12289	43934	acttagaacctcgctcgtgtagat	U53584	86538	ggcccttttgcctccagatgcagag	U31966
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1360	cacgagcctctgacatccctagtca	W44217	43964	cagctgaactgtgtgtgtgtcttaa	L01991	86568	ctgagcctaatttcaagtgtgtac	AA107731

TABLE 1

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1363	atggcaccctgtgtgccaagaagc	M91602	43967	cctggctccaaaagttagaggttcag	U53591	86571	cagatcagccatttacttctctac	U36788
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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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1699	atcccaaatccacagtgcatattt	D76440	44303	gtttgccattttctgtgaacag	Z26580	86907	caatacataggccaggtgtgtatg	X97650
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TABLE 1

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1702	tctgttcttctgtatgggactgat	D76440	44306	tccatctgtctgtgattgggtcac	Z26580	86910	cttcatggccagggaaggtctcttc	X97650
1703	taacagcaacgcagacctgagcaa	D76440	44307	ctctgaagggtgccccatttatag	Z26580	86911	gaagggtctcttccaggaaactatg	X97650
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1705	ggctcctctacgacattcctgacatc	W45807	44309	ctccaaaataatcatttcttct	Z26580	86913	aagatctgatctccatccaccagc	X97650
1706	caagtttcagcctcttagcaagtac	W45807	44310	ttcatctctgatgacatagagg	Z26580	86914	tgggattccaaacctgcccagtgga	X97650
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1722	catcaaccagagtgtaagtttctg	W45807	44326	cattaacgagccttccggagctg	X17500	86930	gttcaagccaaagagctccaaac	AA107887
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1731	ctctgagagcgccaagtcctgagat	X74671	44335	tctggcagctcgaagcagctccag	U62523	86939	tcctcagcacttgaccaagaccgcg	AA107893
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1735	aggttctcacaatgtgttctaggt	X74671	44339	aaacggaaaagctaatctgcatgg	U62523	86943	cacttgaccaagaccgcgagagaga	AA107893
1736	acataccgagcttgcacattatgc	X74671	44340	gaattgctattgatacgtattgac	U62523	86944	acttgaccaagaccgcgagagagac	AA107893
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1747	gatgtcaccagggcaacctgtctc	W45834	44351	atagatggccagggtttagatgct	U62523	86955	ctcaggacctatagatgaactatta	U26459
1748	ttgcttccgtccacagttatagttt	W45834	44352	gtacacagaacacacagctgacct	X85169	86956	agagcttgcctcgaagctgctcgac	U26459
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TABLE 1

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1771	tactctccactgaagccaacttca	M35131	44375	ctggagctgctgttgcattttca	X92664	86979	tatgtaccaccagtagaataaagg	U57343
1772	ccactgaagctccacttcaattgct	M35131	44376	ctctattgttccctttgacagat	X92664	86980	ttatctgtactctatcttactcaa	U57343
1773	aagtcacacttcaattgcttccatg	M35131	44377	ttgttccctttgacagattgcaac	X92664	86981	gtactctacttactcaaatactgt	U57343
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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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2311	atgtgtgtgtgtgtgtgtgtgtgtgt	W47719	44915	gtgtgtgtgtgtgtgtgtgtgtgt	U34920	87519	tgtgtgtgtgtgtgtgtgtgtgtgt	U27455
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TABLE 1

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TABLE 1

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2384	cataactgtcactcaagaaggtgat	X16995	44988	atcaccagaaataaacacactctgt	D45858	87592	aagatcatttccaggatgacaacac	AA139606
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TABLE 1

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2991	tgcttagatgcacacacataata	U04055	45595	ataccagcaaaaatcattttgagg	AA022254	88199	gtctgtctctcatcagaaacca	L29006
2992	ttctagatgcacacacataata	U04055	45596	ccagcaaaaatcattttgaggatg	AA022254	88200	ttctcatcagaaacccagcttct	L29006

TABLE 1

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2994	actatctatagctagatcttcatg	U04055	45598	gctgtcagatctctgttcatgtctt	U50595	88202	tttcttctgctggtatgaaaacga	L29006
2995	atctatagctagatcttcatgagtg	U04055	45599	ctggagccatggcatgacgggccc	U50595	88203	agtcacgtctcacagggcgctgag	L29006
2996	ctatagctagatcttcatgagtgct	U04055	45600	gccatggcatgacgggcccgaagcct	U50595	88204	gtctcacagggcgctgagcccagt	L29006
2997	agatctcatgagtgctgtgtttct	U04055	45601	gaagcctgataccaacagaggtgac	U50595	88205	gcttgagccagtgtaaggtattta	L29006
2998	atctcatgagtgctgtgtttctg	U04055	45602	agacaggatcttccagtgactctgg	U50595	88206	ccctatctcatcattagcattat	L29006
2999	gactctattcagggtacataccacaca	U04055	45603	acagggacatcatctggaagcat	U50595	88207	ataccatcaactcttgaaggtct	L29006
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3001	tgcactctcaggggaaccaaacacc	W48026	45605	ctgataaccccggggacacagcaa	U50595	88209	tgggaccccttaagccagagagtg	L29006
3002	tcccacttgggggtaccattgctct	W48026	45606	ggggcacacagcaactctcatatct	U50595	88210	gtcccagtggtcttaagatcaga	L29006
3003	actgacttcagtgctggcagcgcc	W48026	45607	acagcaactctcatctcacggg	U50595	88211	tgataggcctccgaatcacacatt	L29006
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3005	cggccctcggagctggtcttctct	W48026	45609	algtcttcccctggaagctggcct	U50595	88213	tggttccattacttcagaccta	L29006
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3029	ccagacatgctctgtagggcaggt	M23998	45633	actgcagtagccagtagccagtag	AA022273	88237	ggacactcattaaacagctgtgc	D38218
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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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3335	ccacatcagtagcgagagacatcc	M55561	45939	aatcttagcaatgggtgactagct	Z22111	88543	ctgccttaggaaggtgcctgcagct	D31943
3336	cgtagacacccagctagggcacaata	M55561	45940	tgttagcttagctaacccagaagttc	Z22111	88544	taggaagttgcctgcagctgagaga	D31943
3337	tctgaactcatctctcaagcctgc	M55561	45941	ctacatataatcatgagcttgagg	X54352	88545	tacatacacacclaaagacttta	D31943
3338	ctctcaagctgtccagagcccag	M55561	45942	atataatctgagcttgaggacagag	X54352	88546	tcgaatgtctgggccatccacct	D31943
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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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3743	ctgttgtaacaccagcagcgtcaag	M29464	46347	taatccggagccttcatacgcaact	AA023665	88951	aggtcttaagatcccagagggtcag	Y07941
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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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5130	gcaggaatcaccaacttggccgac	M88299	47734	ctgtcaaggtactgtgcttagcctt	X15643	90338	atcgtgaatcagctgcagaaggagc	AA110514
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5136	ccagcagcagacccggagcagctgc	M88299	47740	gtaatacaggttcttactctctaa	X15643	90344	aggacccaccaagtatccggcatag	U73460
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5168	ccacagcttctctgggacctctgt	X66602	47772	ccgtagctggcctcacaggaatgga	AA027667	90376	gccaaggacaaccagcagagaagcca	AA111635

TABLE 1

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5171	aagaggcagactcatctcctggcgag	X66602	47775	ttgtccaccgcggaacattgccatg	AA027667	90379	gtcaactctcggctgaggagatca	AA111635
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5209	gtgtcacaagccagcaagcaagattc	W49367	47813	caattagccactgcgtttatcgaga	X78684	90417	acatacacacacttaccctcatg	U77356
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5212	gttaaccaatagtcaggcctcagca	W49367	47816	aactgtcalaccactgaactgagct	X78684	90420	agtggtcactgcctgggactctta	U77356
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TABLE 1

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5240	gcacaagacacccgcgcaaaagcgcg	W49376	47844	ctgtctgaacctgatggtgaaacct	AA027694	90448	actgtgataaaccagtcacagaagt	AA142505
5241	acaagacacccgcgcaaaagcgcgct	W49376	47845	acaacttctgtcgctgtgataaagg	AA027694	90449	ggataaaccagtcacagaagtctc	AA142505
5242	gacaccgcagcaaaagcgcgctgcac	W49376	47846	ctttctggcgctgataaagggtgtg	AA027694	90450	accagtcacagaagtctctctgcag	AA142505
5243	caccgcagcaaaagcgcgctgcacag	W49376	47847	ttgtttggcgacctgagcagaagtgt	AA027694	90451	cagtcacagaagtctctctgcaggtc	AA142505
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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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5778	gtttatgccccaaacaatcactg	L02241	48382	ctccagaggagaccacgatcgaca	AA028748	90986	tgaaggctctgtaactgtaccggc	AA111262
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TABLE 1

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5783	agcagcagcactatttgaattgct	Z14986	48387	aagtcacggaggacatcttagcaag	AA028748	90991	gagatccgaacgccagggacgatcca	AA111262
5784	acagcagcactatttgaattgctatt	Z14986	48388	acctctaccatgagagatcgccatc	AA028748	90992	atccgaacgccagggacgatccagg	AA111262
5785	tatttgaggggcagtgctattta	Z14986	48389	cctctaccatgagagatcgccatca	AA028748	90993	cacgcgtgccatctggagagaaagt	AA111262
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5800	aaccactcttctgtctgtctgagg	M94632	48404	cgcatttgcacagcttctgatctct	AA028755	91008	gtgtccaggacagtagctcgcacatc	U08373
5801	ccaacaggcactctagacagagca	M94632	48405	actgtcacagcttctgtatctctg	AA028755	91009	acagtagctcgcacatctgcacaaac	U08373
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5810	tgtaatgccttgaggaataaagtgt	M94632	48414	cacttggatcgcctgtagtagtagc	AA028755	91018	gcaaaagcaagccgctctggaacaa	U08373
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5813	tggtgacacgcctgtgtaagaccct	M94632	48417	gggtcgttcatctgtgtagtagtagc	X58861	91021	tgatgagagccagtagtagtagtagc	U08373
5814	cagcctgtgtaagaccctgtcact	M94632	48418	ttcatctgtcagtagtagtagtagc	X58861	91022	tgagagccagtagtagtagtagtagc	U08373
5815	tgtagatgacctgtcactttacc	M94632	48419	aaggggctcttccaggtgttagcag	X58861	91023	gagcccgagtagtagtagtagtagc	U08373
5816	ttacccttaactacagcatatgca	M94632	48420	aagggctcagtagtagtagtagtagc	X58861	91024	cccactgaagtagtagtagtagtagc	U08373
5817	tacagcatatgtagtagtagtagtagc	M94632	48421	cgcatttaccagtagtagtagtagtagc	X58861	91025	cttagagtagtagtagtagtagtagc	U08373
5818	tgctggccacaagaccgaagaggg	M94632	48422	ggcactggaagtagtagtagtagtagc	X58861	91026	atctactactgagtagtagtagtagc	AA111263
5819	tggtgtagtctgtgtgtgtgagaa	W49956	48423	gacagcatctttagtagtagtagtagc	X58861	91027	ttaccagagtagtagtagtagtagc	AA111263
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5848	gaccttagtagtagtagtagtagtagtagtagc	W49959	48452	ctgtagtagtagtagtagtagtagtagtagtagc	AA028730	91056	ctgtagtagtagtagtagtagtagtagtagtagc	AA111386

TABLE 1

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5854	gagacacagcaactatagcacagcg	W49959	48458	atttcaccagaactccgagctcat	AA028784	91062	ctaggacatcatgtctctggaatg	AA111386
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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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6663	ggcttccatgcatggaactccca	J00621	49267	catcatgggctctgtgaattccaga	AA030482	91871	attcccaacaagcagacaccgactt	AA117004
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TABLE 1

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6667	taacaatcgctgttgattgccttg	J00621	49271	cctgactctgctggaagaccaca	AA030482	91875	acaagcagacaccgacttcaaca	AA117004
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TABLE 1

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6799	tggtccgtggcacatggacctgta	W50329	49403	ggagacccttttcagagctctt	AA031244	92007	gtgtgtagctctatgtgagagcta	AA117151
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TABLE 1

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6805	tggagctcatgcttgaagagagc	W50138	49409	ggccgcccgcactactacgcagaa	AA031244	92013	ttttctggttcaagcgatggact	AA117151
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6808	ccgctgagtgcttccgcatccttg	W50138	49412	tcactacgcagaaatcatggagaa	AA031244	92016	agaagcactaggcacagcccgttg	AA117151
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TABLE 1

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TABLE 1

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6939	acatcactgactgccactgaaggg	X60103	49543	tgctatgctctacaccgcaagtt	AA030865	92147	gttgagaataccactcactgtgaat	AA117227
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TABLE 1

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7007	aaagccagctttgattattaggaatc	K02927	49611	ccaagcatgtgacctgactgcac	X67083	92215	ttgcatcacagagtggatgaacc	AA117313
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7208	taccatttctcagcttggctc	K02060	49812	tcataaggccagacggcaaaccaa	X78874	92416	gcgaactcagagtcactgactt	W29527

TABLE 1

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TABLE 1

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7279	acatctaggctgaactcatcaaaa	J03776	49883	atagatatcgaccctatgacattg	X52046	92487	tacttgaccacgtgattcggaat	AA117715
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7282	cacactctgaagtgagggtatgtgc	J03776	49886	caccctcatagggatctgggaaa	AA032912	92490	tgaccacgtgattcggaattacac	AA117715
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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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8091	tgagccacggcgacagaaacgaga	D84372	50695	taactgtctctgattctcccg	X75013	93299	agaacatcagttctcatcaagctat	D17406
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TABLE 1

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8095	cctgcagcctggtagcactggctgc	W50891	50699	tactgccaccttttcaataagct	X75013	93303	tgcccaggggattccatgtaggagt	D17406
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8103	gatcctgtccaaatcccgtagcc	W50891	50707	aattccagaccagaccattggccct	X75013	93311	tttccaatcatccaggtagctcgc	U12564
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8131	aacagctacaatttgcatacca	W50904	50735	gccatcatgaataacctcatgtgta	U05265	93339	gcctcctcagagcctgtctgtgtg	AA118701
8132	acagctacaatttgcataccaat	W50904	50736	atgaataacctcatgtgtatcagaa	U05265	93340	accttctttgacactcagaaacag	AA118701
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8134	agctacaatttgcataccaatct	W50904	50738	atcagaagcttctcagaatttggg	U05265	93342	tcagagcctgtctgtgtgtgtgtg	AA118701
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8160	ttatctcctgtgtcccttagcact	M37759	50764	cagcttccgagagacatttagatta	X63099	93368	atcaactacagtagcctcagtag	AA118692

TABLE 1

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8163	cttcaactcagatttgcttttctg	M37759	50767	acactactgaggggactgcccggct	X63099	93371	gcctcaggcagaacacataattct	AA118692
8164	tttggtcttctgctcacaagaagag	M37759	50768	tgggcaacccctcagaaaaagcaca	X63099	93372	ggcagaacacataattcttcattc	AA118692
8165	tgtctcacaagaaggccatctgc	M37759	50769	cccttcagaaaaagcacagtgaaa	X63099	93373	ctatgactcctatcactctggctac	AA118692
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8177	gccagcctgtgtggctgtcggaagt	W50919	50781	gaagccactgctgtgtactaaagac	AA034569	93385	tcatcaatctacagggtgctctcag	AA118692
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TABLE 1

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TABLE 1

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TABLE 1

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TABLE 1

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8568	tagcggaactcaccatccagacct	W51059	51172	ctgtcgggtgagcgtgcaacgactg	AA036584	93776	gatagccttcttccatttggtta	D21252

TABLE 1

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